UNITED STATES NAVAL OBSERVATORY

CIRCULAR NO. 181

U.S. Naval Observatory, Washington, D. C. 20392 December 15, 2009

Nutation Series Evaluation in NOVAS 3.0

by

George H. Kaplan

Nutation Series Evaluation in NOVAS 3.0

Introduction

This circular describes the computation of nutation in the Naval Observatory Vector Astrometry Software (NOVAS)[1], version 3.0. A detailed description of NOVAS 3.0 may be found in USNO Circular 180 (Kaplan et al. 2009)[2], which consists of user's guides for both the Fortran and C versions. Nutation is a small periodic oscillation of the Earth's axis with respect to a space-fixed reference system ("inertial space") caused by the torque of the Sun and Moon—and to a lesser extent, the other planets—on the Earth's equatorial bulge. Nutation is usually modeled by lengthy trigonometric series that, when evaluated for a specific date and time, yield the values of two ecliptic angles: the nutation in longitude, $\Delta\psi$, and the nutation in obliquity, $\Delta\varepsilon$. The evaluation of the nutation series is generally the most computationally intensive part of calculating the positions of celestial objects with respect to the traditional celestial coordinate system defined by the true equator and equinox of date. NOVAS provides several nutation series with different numbers of terms, which the user can select depending on the accuracy requirements.

Background

In the summer of 2000, the IAU General Assembly, meeting in Manchester, England, adopted Resolution B1.6 that called for new models for precession and nutation, to be known collectively as the IAU 2000 precession-nutation model. The new nutation theory was published by Mathews et al. (2002) and the new precession theory is the P03 development of Capitaine et al. (2003). The celestial pole that is predicted by IAU 2000 precession-nutation is referred to as the Celestial Intermediate Pole (CIP).[3] NOVAS 3.0 implements these models.

These models replaced the precession model by Lieske et al. (1977) and the IAU 1980 Theory of Nutation (Seidelmann 1982), the latter developed by Wahr (1981). The pole defined by these older theories was referred to as the Celestial Ephemeris Pole (CEP). The Lieske et al. precession and the Wahr nutation are implemented in NOVAS version 2[4] and earlier (Kaplan 1990).

A general description of precession and nutation, the observational results that motivated the change in theories, and a comparison of the major components of the old and new developments are given in Chapter 5 of USNO Circular 179 (Kaplan 2005)[5]. A recent

---

[1] http://www.usno.navy.mil/USNO/astronomical-applications/software-products/novas
[2] http://www.usno.navy.mil/USNO/astronomical-applications/publications/circ-180
[3] Strictly, the CIP is defined by both the theoretical predictions and observational corrections.
[4] The previous releases of NOVAS were NOVAS F2.0 (Fortran) and NOVAS C2.0.1 (C).
[5] http://www.usno.navy.mil/USNO/astronomical-applications/publications/circ-179